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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Morris Taylor MURRAY, et al.

Serial No.: 10/663,437 Group No.: 1725

Filed: September 16, 2003 Examiner: L. Tran

For: MAGNESIUM PRESSURE CASTING

Attorney Docket No.: U 014758-5

Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

SUBMISSION OF DECLARATION UNDER 37 C.F.R. 1.132

A Declaration is attached to traverse rejection.

Respectfully submitted,

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IN THE UNITED STATES PATENT AND TRADE MARK OFFICE

Applicant	: Murray et al	Examiner	: L. Tran
Serial No.	: 10/663437	Group Art Unit	: 1725
Filed	: September 16, 2003	Docket	: U 014758-5
Title	: MAGNESIUM PRESSURE CASTING		

DECLARATION

I, MORRIS TAYLOR MURRAY, of 51 Teal Lane, Briar Hill, Victoria 3088, Australia, declare and say as follows:

1. I am a co-inventor of the subject matter claimed in the above-referenced patent application Serial No. 10/663437, filed September 16, 2003 (hereinafter referred to as "the present application"). I am the same Morris Taylor Murray who on October 18, 2002, made a declaration filed under cover of a communication dated October 24, 2002, filed in respect of parent application 09/554507 (now US patent 6634412).

2. I hold a Bachelor of Engineering Degree and a Master of Engineering Science Degree, each from Monash University, Clayton, Australia. I also have a PhD from

Melbourne University, Parkville, Australia. Both nationally and internationally, I have in excess of 25 years of industrial and research experience in relation to products produced by, and processes for, pressure casting of magnesium and other non-ferrous alloys. Full details of my academic and professional experience to October 18, 2002 are set out in pages CV/1 to CV/19 of my Curriculum Vitae attached to my declaration made on that day and filed in respect of said parent application 09/554507. I resigned from CSIRO as of February 6, 2003 and, since that date, I have operated successfully as a consultant to the diecasting industry in Australia, the USA and in several other countries through my company M. Murray & Associates Pty. Ltd. (see www.mmaa.net.au).

3. I have carefully read, and I am thoroughly familiar with, each of Office communications mailed respectively on January 10, 2005 and May 13, 2005. Issues raised in the January 10 communication are addressed later herein. It may assist if I first address paragraph 11 of the May 13 communication in which it is stated:

"Applicant argues that Kato et al fail to teach such that substantially all of the alloy flowing in the die cavity is in semi-solid state. Examiner agrees. However, applicant's argument is not in commensurate with the scope of the claim. The claims are directed to an apparatus. The molten metal can either be semi-solid or liquid is dependent on the temperature of the casting sleeve. Therefore, the apparatus is capable of casting a product having substantially all of the alloy flowing in a semi-solid state."

These final two sentences of this quoted passage fail to address relevant issues. This is so even though the apparatus of Kato et al does have the ability to cast a product with alloy flowing into the mold cavities either in a semi-solid state or in a liquid state. As indicated by the Examiner, these alternative abilities are dependent on the temperature of the casting sleeve. However, as indicated in paragraphs 4 to 7 herein, the abilities of Kato et al in this regard do not disclose or suggest the apparatus of the present invention as defined by the claims.

4. In conventional high pressure die casting, there is a metal flow system which receives alloy at one end and which, at its other end, supplies alloy to a die or mold cavity. That is, the respective ends of the system provide for "alloy in" (or AI) and "alloy out" (AO). Exactly the same applies to the metal flow system of the claims defining the present invention, and also to the flow system of the apparatus of Kato et al. Thus, each of the flow systems can be designated as an "alloy in – alloy out", or an AI – AO, system. Despite this simplistic parallel, it is to be recognised that the processes differ significantly, as is evident when the state of the alloy is taken into account. That is, the processes differ depending on whether the alloy is liquid (L) or semi-solid (S). The processes differ further when any means causing a change in alloy state is taken into account. Thus, the processes are more realistically recognised as differing in that:

   (a) conventional high pressure die casting is characterised as liquid in – liquid out (or LI – LO) with no change of state of the alloy in the flow system;

   (b) Kato et al is characterised as enabling either:

(i) semi-solid in – semi-solid out (or SI – SO) with no change of state of the alloy in the flow system, or

(ii) semi-solid in – liquid out (or SI – LO) with a thermally activated change of state of the alloy in the flow system; and

(c) the present invention is characterised as liquid in – semi-solid out (or LI – SO), with the change of state of the alloy in the flow system being by control of alloy flow velocity rather than thermally activated.

Alternative (b)(i) of Kato et al is more akin to conventional high pressure die casting in that die cavity fill is achieved by alloy in the same state as the alloy is supplied. That is, in (b)(i), there is no change of state. However, like the present invention, alternative (b)(ii) of Kato et al involves a change of state, but alternative (b)(ii) differs from the present invention in that:

- the change of Kato et al is from semi-solid to liquid (SI – LO), whereas the invention provides a change from liquid to semi-solid (LI – SO), and
- the change achieved by Kato et al is thermally activated (due to its dependence on casting sleeve temperature, as recognised by the Examiner), whereas the change required by the invention is driven by control of alloy flow velocity and not by thermal activation.

Prior to the present invention, it was not known that the LI-SO change of state required by the invention could be driven and achieved by control of alloy flow velocity. The LI-SO change in the course of practical alloy flow through a flow system to a die cavity in apparatus disclosed in Kato et al (but with cooling rather than heating) is not known to be possible by thermal activation.

5. In paragraph 11 of the communication of May 13, 2005, it is said that "applicant's argument is not in commensurate with the scope of the claim. The claims are directed to an apparatus.". The reasoning underlying this quoted wording is not correct and is negated both by the above matters and by the Examiner's recognition of the fact that, in Kato et al, the metal can be either semi-solid or liquid "dependent on the temperature of the casting sleeve", such that the apparatus of Kato et al "is capable of casting a product having substantially all of the alloy flowing in a semi-solid state". It is correct that the claims to the present invention are directed to apparatus. However, the claims specify apparatus which functions to achieve a result which the apparatus of Kato et al is <u>not capable of achieving</u>. That result is surprising and was not known before the present invention, while it is a result which provides a number of very significant practical benefits. The disclosure of Kato et al, despite the fact that its apparatus is capable of casting a product with alloy flowing into a die cavity in a semi-solid state, teaches that the casting should be with alloy flowing into a die cavity in the liquid state and <u>not the semi-solid state</u>. In this respect, the teaching is away from the present invention. However, even ignoring the fact that Kato et al thus teaches away from the present invention, there remains the differences that for alloy to flow into the die cavity in a semi-solid state with the apparatus of Kato et al, alternative (b)(i) of paragraph 4 herein would apply. That is, the alloy flow to the die cavity would be by semi-solid in – semi-solid out (SI – SO), with no change of state for the alloy in the flow system, and there is no ability for the apparatus to utilise an input of liquid (molten) alloy.

6. The metal flow system of the present invention as defined by the claims necessarily is different from apparatus disclosed by Kato et al. The differences arise from the following:

   (i) the present invention has no necessity for (and typically can not have) means equivalent to that of Kato et al for controlling the temperature of the casting sleeve;

   (ii) the present invention necessitates a runner into which molten alloy is able to be received under pressure and a controlled expansion region necessarily located between the runner and the die cavity whereas in Kato et al each runner 46 communicates directly with a cavity 47 without an intervening region of any type.

   (iii) the present invention necessitates that the flow system has a form providing for the control of alloy flow velocities, comprising the effective cross-sectional area of the runner and the form of the expansion region, which causes the alloy to undergo a change from liquid to semi-solid by control of alloy flow velocity whereby the alloy flows, in the semi-solid state, into the die cavity. In contrast, the options for Kato et al do not encompass or enable this, and amount to no more than the alternatives (b)(i) and (b)(ii) detailed above in paragraph 4 herein.

7. To elaborate on matters (i) to (iii) detailed in paragraph 6 herein, it should be noted that:

(a) The means in Kato et al for controlling the temperature of the casting sleeve is a heating means for melting solid alloy to a semi-solid state and thereafter melting the semi-solid alloy to a fully liquid state. This is fundamental to the disclosure of Kato et al as the advance over the prior art is to create molten alloy in this way in order to achieve die cavity fill with molten, rather than semi-solid alloy, after starting with solid alloy. This is completely in contrast to what is necessary for the present invention, while the invention further differs in utilising flow velocity control to achieve a change from the liquid state to the semi-solid state. Providing heating means acting to convert semi-solid alloy to liquid would be completely inconsistent with the present invention, and would subvert the invention and its entire rationale.

(b) While the apparatus of the invention is operable with an input of liquid alloy and, indeed, necessitates this, the apparatus of Kato et al is not operable with an input of liquid alloy. The controlling of the temperature of the casting sleeve of Kato et al needs to be relatively precise and, in particular, it needs to avoid melting of alloy along the full length of the casting sleeve. If all of the alloy in the casting sleeve (i.e. within the cylinder barrel 2) is in the liquid state, it will not be possible effectively to advance the alloy in barrel 2 to retract screw 10, or effectively to push alloy into the die cavities 47 by axially advancing screw 10. That is, the screw per se can push a solid but, when the screw is entirely within a liquid, it can not push the liquid. Screw 10 requires solid alloy around it in order

that with the solid alloy, the screw 10 can function as a ram, a function it does not have when entirely in a liquid.

(c) Two issues arise in relation to matter (iii) of paragraph 6 herein. The first is that Kato et al does not disclose a flow system which has a form providing for relevant control of flow velocities as required by the invention. The second is that, even if it were incorrectly assumed that Kato et al did disclose such a system, it would not be able to function as required by the present invention due to matters (i) and (ii) of paragraph 6 and matters (a) and (b) of this present paragraph. This is elaborated in more detail in subsequent paragraphs 8 et seq. herein directed to the above-mentioned January 10 Office communication.

Of further relevance to these issues, Kato et al teaches the use of solid alloy in the form of particles such as from mechanically chipping ingots or shavings resulting from cutting operations. These costly further operations would hardly be warranted if it was possible simply to supply molten alloy to the casting sleeve (i.e. barrel 2). Additionally, before the present invention it was not known that alloy could be caused to change its state from liquid to semi-solid by control of flow velocities. It therefore can not be material to contemplate what, if any, change to the express disclosure of Kato et al might enable use of that previously unknown change of state.

8. Claims 50 to 52, 54 to 57, 60 to 62 and 64 to 66 are rejected in the January 10 communication as being anticipated by US patent 5685357 (Kato et al). The rejection is followed by a statement in which it is said that Kato et al discloses:

a) A flow system comprising a runner, a controlled expansion region (45) with an effective cross-sectional area of the runner for determining the flow velocity and a form of expansion region which enables alloy flow therein to spread laterally;

whereby:

b) The form of the flow system enables the flow velocity in the runner and the reduction in flow velocity in the expansion region by which the state of the alloy is changed from a molten state in the runner to a semi-solid state for flowthrough the gate and into the die cavity.

This support for the rejection appropriately reflects the present invention. However, the statement is without a basis in Kato et al and, in fact, it is extensively contradicted by the requirements consistently stressed in Kato et al.

9. It is important to note the features that are stressed in relation to the process of Kato et al. The first feature, stressed as fundamental in Kato et al, is that the process requires injection of molten metal into the mold (and, hence, into the cavities). That is, there is no disclosure anywhere that Kato et al requires or enables injection into the cavities of alloy in a semi-solid state. The following passages should be noted:

Column 1, line 11: "then injecting the molten feed into a mold".

Column 3, lines 14 to 24, in particular lines 21 to 24: "injecting metallic feed into a die ... wherein the metallic feed is set at a temperature above the liquidus of the metallic feed while injecting".

Column 6, lines 23 to 55, in particular lines 48 to 50: "thereby injecting the stored, completely molten metal into the cavities 47".

Column 11, lines 46 to 58, in particular lines 55 to 58: "injecting the metallic feed into a die ... wherein the metallic feed is set at a temperature above the liquidus of the metallic feed while injecting".

Claim 1, see the "melting" step followed by the "injecting" step.

Figures 4A to 4D, see the description thereof which makes clear that the alloy is in the liquid state for injection into the mold die cavity.

In addition to these passages, there is no reference to alloy changing its state from the liquid or molten state to the semi-solid state in the process of Kato et al, or of alloy in a semi-solid state being injected into mold cavities.

10. The second feature, stressed as fundamental in the process of Kato et al, is that the molten feed to be injected into the mould is produced by melting solid metal. This is expressly stated at several passages – see, for example:

Column 3, lines 16 to 18: "melting a metallic feed in a solid state by heating it from outside and by friction and a shearing generated by a rotation of a screw".

Claim 1, see the first step of "feeding a metallic feed in a solid state" and the third step of "melting the metallic feed".

Even more compelling is the description with reference to Figures 1(A) and 1(B) – see:

Column 3, last line to column 4, line 45; in which the discussion is of chips from ingots, or granulated particles obtained by dropping melting metal into water, having a small particle size but not a powder".

Column 6, lines 18 to 23: "the metallic feed K having a particle size of no more than 10 mm".

Examples 1 to 3: in each of which the grain size is given for the metallic feed particles.

The disclosure of Kato et al stresses the use of a form of apparatus that will only function effectively with a supply of solid metallic feed which must be melted in a controlled manner to provide the molten metal. At column 5, lines 7 to 15, Kato et al points to the need to use a temperature not less than about 30°C higher than the melting point of the solid metallic feed. However, it also is indicated in that passage that the temperature is not to be such that the feed melts prematurely. If the metal is molten along the full length of screw 10, the molten metal will not be advanced effectively by either rotation or longitudinal movement of screw 10. The same would apply if molten metal was supplied to the apparatus. There must be solid metal in at least the feed zone shown in Figure 1(B) to enable rotation of the screw 10 to advance the metal as it melts and to enable screw 10 to act as a ram when moved longitudinally. Thus, despite the express requirement stressed in Kato et al for injection of molten metal into the die cavities, a supply of molten metal can not be used with the form of apparatus stressed by Kato et al.

11. Dealing more specifically with what Kato et al is said to disclose, it is not necessarily the case that it is appropriate to regard sprue (45) being suitable for functioning as a controlled expansion region. This is because there is no disclosure of how the cross-section of the sprue (45) varies in longitudinal planes perpendicular to Figure 1(A) and, hence, there is insufficient relevant information. That is, it is not clear whether the sprue (45) increases in cross-sectional area in the flow direction. Hence it is not possible to assert that the form of the sprue (65) enables alloy flow therein to spread laterally in a manner enabling a reduction in flow velocity.

12. Notwithstanding the possible form of sprue (45), claims 50, 62 and 66, and hence all of the rejected claims, require the expansion region to receive alloy from the runner, with the alloy passing from the expansion region to the die cavity. That is, the expansion region of the present invention is between the runner and the die cavity. In the arrangement described in Kato et al, alloy passes from the sprue 45, to runners 46 and, from runners 46 to cavities 47. That is, in Kato et al, the runner is between the sprue 45 and the cavities 47, and not as required by the invention.

13. Each of claims 50, 62 and 66, and hence each of the rejected claims, requires:
   (i) the alloy to flow from the runner into the expansion region,
   (ii) the alloy flow velocity to be reduced in the expansion region from the level in the runner; and

(iii) the form of the runner and expansion region enables flow velocities in the runner and expansion region by which the state of the alloy is changed from the molten state in the runner to the semi-solid state in the expansion region, for subsequent die cavity fill by semi-solid alloy.

None of these three requirements can be found in, and none of these is relevant to, Kato et al. Also, the change of state from molten to semi-solid as a consequence of the reduction in the controlled flow velocities, is not known to have been disclosed before the present invention. Kato et al is devoid of any teaching relevant to a change from molten to semi-solid by any means at all, let alone by control of flow velocities. Kato et al requires a change of state from solid to semi-solid, and then from semi-solid to the molten state and, in each case, by externally applied heat and by frictional heat generated by the rotating screw (10).

14. As to claims 54 to 57, 64 and 65, it is said in the January 10 communication that Kato et al disclose the controlled expansion region is provided by a step-wise increase in cross section. However, this is not stated by Kato et al. Rather, insofar as the three-dimensional form of sprue (65) can be positively characterised, the sprue (65) can be seen to have a uniformly increasing width in the plane of Figure 1(B). A step-wise increase is one which is one which proceeds as at least one step, such as of steps of a flight of stairs.

15. Also, the system (of Kato et al) is said in the January 10 communication to be capable of a flow velocity between 140 to 165 m/s. However this statement also is not supported by any express or implied passage of Kato et al, while Kato et al

would be understood by persons skilled in the art as teaching away from a flow velocity of 140 to 165 m/s. On flow velocity, Kato et al indicates little. However, what is stated is at variance with the flow velocities usual with the present invention. At column 5, lines 16 to 23, and again at column 6, lines 46 to 55, there is reference to an injection speed of at least 50 cm/s, while each of Examples 1 to 3 specify an injection speed of 60 cm/s. These figures correspond to greater than 0.5 m/s and 0.6 m/s, respectively. These figures are indicated at column 5, line 21 to be 5 times as fast as the injection molding of plastics. However, they are about 1% of the injection flow velocities used in conventional high pressure die casting of magnesium alloys which usually are of the order of about 50 m/s. The injection velocities thus are even further removed from the still higher runner flow velocities of 140 to 165 m/s usual with the present invention.

16. There is a vast disparity between an injection velocity of 50 or 60 cm/s (i.e. 0.5 or 0.6 m/s) used for the system of Kato et al and the flow velocities of 140 to 165 m/s for the present invention. Also, there are several reasons why it would not be practical to seek to use the system of Kato et al at flow velocities of 140 to 165 m/s and why the system of Kato et al is not capable of such high velocities. These are as follows:

a) In Kato et al, the molten alloy is stored in accumulating zone (15) prior to a casting cycle. The molten metal does not move axially through nozzle (3) during this time. Rather the molten metal is axially at rest and causes screw (10) to retract axially – see column 6, lines 41 to 45. In order to achieve the injection velocity of more than 50 cm/s, such as

60 cm/s, the molten metal has to be accelerated from rest. For this, unit (20) has to overcome the inertia of screw (10), the inertia of the molten, semi-solid and solid metal, as well as the frictional resistance of semi-solid and still solid metal in barrel (2). The system is doing well in achieving an injection speed greater than 50 cm/s. However, it would require an extra-ordinarily overpowered drive unit (20) able to achieve an injection speed even approaching a flow velocity of about 50 m/s (the difference between 50 cm/s and 50 m/s, of course, being a multiplier of 100).

b) It is important to bear in mind that, as in conventional high pressure die casting, Kato et al is concerned with die cavity fill with molten alloy. In die casting, it is well known that injection flow velocities much in excess of 50 m/s, such as from 70 to 80 m/s, will result in damage to the mold due to the high velocity of impingement of molten metal. This is due to die cavity fill being as described in Figure 8A of the present application, in which a concentrated jet of molten metal impinges on the cavity wall. Thus, it is within basic understanding in the art that, even if the apparatus of Kato et al could achieve an injection velocity remotely approaching 50 m/s, it would be highly undesirable to exceed that level to a significant extent. Injection of molten metal at velocities approaching 140 to 165 m/s simply would not be used by persons skilled in the art.

In contrast, the present invention achieves die cavity fill with semi-solid alloy, not molten alloy. This results from alloy at a flow velocity of 140 to 165 m/s in a

runner being caused to undergo a reduction in flow velocity, and hence a change of state from molten to semi-solid, in the controlled expansion region prior to entering the die cavity. As a consequence, die cavity fill is as described with reference to Figure 8B, with the alloy progressing across the cavity on a moving front rather than as a jet. Mold damage therefore is avoided.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements are made with the knowledge and that wilful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such wilful false statements may jeopardise the validity of this application or any patent issuing thereon.

M T Murray

(Morris Taylor MURRAY)

3 JUNE 2005

Dated

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